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Social Dimensions of Engineering Design . . . . . An Engineer's Perspective

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This paper summarizes the opening remarks made by the engineering co-chair of a workshop on the social dimensions of engineering design and design education that was held at Harvey Mudd College in May 2001. Supported by the National Science Foundation, The Boeing Company, The GE Fund, Hughes Electronics, and Harvey Mudd College, Mudd Design Workshop III brought together engineers and social scientists—in their roles as educators, researchers, and practitioners with design interests—to articulate social and societal issues in and for engineering design. The remarks detailed herein were intended to set the stage and suggest a tone for the presentations and discussions that comprised the workshop. The papers that follow in this Special Issue of the International Journal of Engineering Education *include the opening remarks of the Workshop's co-chair, Langdon Winner, and revised and extended versions of the papers presented at the workshop.*

1. PARSING THE MEANING OF 'SOCIAL DIMENSIONS'

THIS third Mudd Design Workshop (MDW III) was designed to be different than its predecessors [1, 2] in that both its Advisory Committee (see below) and its intended audience were to include social scientists alongside the engineers. Thus the title of MDW III. But, what do we mean when we refer to 'the social dimensions' of engineering design? It seems evident that there are (at least) two meanings from which we can choose.

Writ small or viewed locally, there is the social activity of people *doing design* (or people *creating designs*).
Writ large or viewed globally, there is the social impact or the effect on society of the *design completed and implemented.*

An engineer would surely be tempted to make an *engineering approximation* and assume that these two writs or aspects are *uncoupled*, that is, that they are separable phenomena that can each be considered independent of the other. But are they?

2. DESIGN *IS* A SOCIAL ACTIVITY

I believe that Larry Leifer was the first engineering design professor who articulated the notion that engineering design is a *social* activity. Of course, to us, now, this seems such an obvious notion because, after all, it may be said that people working together on a design project:

- *work toward a common goal* and, one hopes, share a vision of the artifact(s) being created;
- *share their individual perspectives* in anticipation that their perspectives will positively interact to create the shared vision; and
- *work together* to achieve a positive outcome that meets objectives and satisfies constraints, and they do so within the allocated time and financial budgets.

Design is done by *groups* and *teams*, but this clearly raises many interesting questions.

How do individuals get put on teams? How do the related selection, appointing, or seconding processes work?
What is the *right mix of skills* (or of actors and roles) for a design team?
What is the *right mix of perspectives* or *disciplines* for a design team?

The very fact that design is done by teams raises some important questions.

3. THE FORMATION OF DESIGN TEAMS

Design projects are, typically and almost invariably, done by design teams. The teams are designed to include different skills. Different perspectives are applied to the artifact being designed and to the processes of its making and of its intended use. Different resource commitments are made toward the artifact's embodiment.

These different skills, perspectives, and resources produce different perceptions of responsibilities both toward the organization that wants an artifact to be created and toward the larger worlds of the artifact's users and the 'outer environment' in

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which artifact and users reside. For such design endeavors, it becomes natural to ask *who* decides: *How* are design teams assembled? *What* those teams will work on, or toward? Which *resources* are available to those teams? What *obligations* and *responsibilities* are assumed by those teams? *To whom* are those teams responsible?

This set of key questions about design project and teams is widely applicable, that is, they are almost certainly relevant regardless of the context in which the teams are formed (or, the context in which the questions are raised about a given design project).

For example, for *student* design teams in *school*, there are several recurring social patterns. The faculty in design courses typically choose the members of teams. The design projects are often selected (or made up) by the faculty. (In Harvey Mudd's first-year design courses the projects are sponsored by not-for-profit clients, while in the Mudd Clinic program the projects are sponsored by industry or government laboratories.) The resources available to student design teams are fairly limited and defined by the departments in which the design courses are taught. The obligations of student design teams are principally toward their faculty and institutions, although in the case of externally sponsored projects students teams experience strong feelings of commitment and responsibility toward the sponsors of their projects.

A similar set of observations can be made about *product* design teams in *industry*. Managers of the company will typically make up the teams, either by appointing members or by seeking volunteers. Projects are generated by a perceived need to develop a product or in response to a client's need for a new product (or device or process). The resources available will, presumably, reflect management's view of what such a design endeavor should cost, with this view typically based on their past experiences with previous design projects. The obligations of industrial design teams are principally toward their employers, although in the case of externally sponsored projects industrial teams may experience conflicting feelings between commitments toward their employers and responsibility toward the external sponsors of the design projects.

Lastly, for teams that design *infrastructure* in the *public arena*, life can get still more complicated because public entities and government agencies enter the picture, as does the magnifying glass of working in what is inevitably a political domain. In principle, obligations toward society ought to be reflected from the very beginnings of public design projects, but the number and diversity (and relative political power) of stakeholders often make such obligations more difficult to clarify. Be that as it may, there is little doubt that, in the three contexts just outlined, engineers and designers study and work in a *social context*.

4. QUESTIONS ABOUT THE SOCIAL CONTEXT OF DESIGN

Having stated some of the more obvious features of design and its true social nature, we wind up having to face—an perhaps answer—four really interesting questions:

What defines the social context of a design project?
Who sets that social context?
Who judges that social context?
When is that judgment of the social context made?

These are clearly very general questions, almost meta-questions that likely can only be answered in abstract terms. For example, we might say that a social context is defined by identifying a client, an intended artifact, an audience of users, a time frame, a design team or organization, an economic framework, and perhaps some model of (potential) interactions with political institutions. Thus, without knowing specifics, we cannot define the social context of any particular design project.

Unfortunately, it is often the case that when answers are offered to these questions for specific design projects, the tones of conversation often become hard, even harsh, and we can identify 'sides' in the very way the project-specific versions of such questions are framed and asked. For example, it is widely believed that the space program is a great scientific success, while the Challenger explosion was an engineering failure. My purpose is not to rehash this old debate, but to note that dialogues about science, engineering, and their consequent technological marvels, are often phrased in ways that one side or group, in this case the engineers, are solely responsible for whatever calamity has happened. Similarly, such 'dialogues' about controversial developments often suggest that the technical work done was initiated solely by scientists and engineers, while ignoring the social contexts in which these various endeavors occurred—whether they be televisions, passenger jets, sports utility vehicles, or nuclear power plants—thus overlooking the many other actors and stakeholders involved in the decision making.

In fact, engineering and science are social forces that result from social choices made by some of the many social voices and powers that exist in society. Engineering and science are not autonomous forces that simply appear as a result of choices made by engineers or scientists. Rather, they are forces enabled or unleashed, depending upon one's viewpoint, by confluences of people and social factors that almost always include far more actors or stakeholders than those engineers and scientists who may be identified with a particular project.

5. IMPLICATIONS FOR HIGHER EDUCATION

Inasmuch as the focus of the Mudd Design Workshops is on design education, I want to

emphasize some issues we face in our teaching, not only in engineering classrooms, but inn higher education more generally. My Engineering colleagues at Harvey Mudd and I have long shared the view that engineering design courses are very natural forums in which we could explore ethics as conflicting obligations [3, 4]. Indeed, we are not alone in this view, which has also been articulated in the relevant philosophy community [5]. Engineering design courses also provide wonderful contexts within which societal impacts can be examined and assessed [4].

Having said this, there are some questions that follow immediately for an engineering program.

Who bears the responsibility of dialogue on ethics?
Who bears the responsibility of dialogue on societal impacts?
How should those responsibilities be distributed across the 48 Engineering credit hours? The remaining 80 credit hours?

These questions are most often answered in a manner that suggests that the responsibilities for dialogues on ethics and on societal impact are clearly borne principally—even solely—by engineering programs and faculty. Further, this exposure to ethics and the impacts of technology on society must be taught exclusively within the courses offered by the engineering department(s) because the other dimensions of a college's or a university's 'general education' are deemed to be more pressing. Indeed, this is not only the argument made by our colleagues in departments of humanities and of social sciences, but even—if implicitly—by our own accreditation authority [6].

However, it seems clear enough, especially within the context of *this* workshop and *its* focus on exploring educational aspects of the social dimensions of engineering design, that the context for the above questions should be broadened to include that of higher education generally. Such broadening of the context would, first of all, allow the inclusion of potential users and of those who may feel the impact of designs created by engineers and scientists. It also facilitates the inclusion of *all of* the other actors, decision makers, and other stakeholders in the context of society at large. Thus, it seems that questions about how engineering ethics will be taught, and by whom, need to be directed to all of the faculty members at a college or university—and not just the engineers and scientists. At this point it seems to me that the relevant question is Why isn't ethics part of the 'gen ed' environment? And, why isn't societal impact part of the 'gen ed' environment?

6. CONCLUSION

I do not expect that a single workshop devoted to the social dimensions of engineering design will answer, for all time, in all places, the questions raised above. This is not a reflection on the distinction and talent gathered in Claremont for MDW III. It is, instead, a reflection of the persistent difficulty of these questions and of all of the underlying contexts. It is my hope that all educators, whether engineers, scientists, social scientists, or humanists, jointly recognize that the contexts for the social dimensions of engineering design are, in fact, *shared* social contexts. Further, I hope that we work together to define and explore the social contexts of engineering design education and practice, and that our dialogues will be characterized not by finger-pointing, but by careful intellectual inquiry.

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